ASSOCIATION BETWEEN HYPERTENSION AND LUNG FUNCTION AMONG ADULT PATIENTS ATTENDING THE GENERAL OUTPATIENT CLINIC OF A TERTIARY HOSPITAL IN SOUTHWEST NIGERIA.

Femi-Adeoye OM[1], Adebusoye LA.[2], Muyibi SA.[3], Sogaolu OM.[4], Femi-Adeoye OO.[5]

1. Department of Family Medicine, Obafemi Awolowo University Teaching Hospitals' Complex, Nigeria
2. Department of Family Medicine & Tony Anenih Geriatric Centre, University College Hospital, Nigeria.
3. Department of Family Medicine, OLA Catholic Hospital, Ibadan, Nigeria.
4. Department of Medicine, University College Hospital, Ibadan, Nigeria.
5. Pharmacy Department, University College Hospital, Ibadan, Nigeria.

Corresponding Author
Name: Femi-Adeoye, Oluwatosin M
Email: femot.2013@gmail.com
Department of Family Medicine, OAUTHC, Ile-Ife, Osun State, Nigeria.

Abstract

Background: Poor lung function is a predictor of all-cause and cardiac mortality. Identifying and modifying risk factors is mandatory for reducing cardiovascular complications among hypertensive patients. Lung function however is not routinely assessed as a cardiovascular risk. The study aimed to compare the lung function parameters among hypertensive and normotensive patients at the general outpatient clinic of a tertiary hospital in southwest Nigeria.

Method: A comparative study of 105 hypertensive and 105 normotensive patients, aged 40-60 years. An interviewer-administered questionnaire was used to obtain data on socio-demographic characteristic and medical history. Anthropometric measurement was obtained and spirometry was performed. The level of significance was set at $p< 0.05$.

Result: A significantly higher proportion of the hypertensive group (33.3%) had poor lung function compared with the normotensive group (21.0%), p=0.044. Logistic regression analysis showed uncontrolled blood pressure (OR: 2.995, {1.243-7.171}) as the most significant predictor of poor lung function and waist circumference above normal (OR: 4.579, {1.136-18.465}), the most significant factor associated with poor lung function in the hypertensive and normotensive groups respectively.

Conclusion: Uncontrolled blood pressure predicted poor lung function, thus lung function assessment as well as ensuring blood pressure control should be advocated among hypertensive patients for prevention of a decline in lung function

Keywords: Hypertension, Lung Function, Waist circumference, Spirometry

Introduction

Hypertension defined as persistently elevated blood pressure above 140/90mmHg is a chronic medical condition with about 90-95% of cases having no specific cause.[1, 2] Hypertension affects approximately one billion people worldwide with more than seven million deaths per year.[3] It is a major risk factor for several vascular disorders such as hypertensive heart disease, coronary heart disease, cerebrovascular disease, peripheral artery disease, chronic kidney disease and retinopathy. [4,5] It has also been established that individuals with low pulmonary function have a higher risk of developing coronary events, heart failure, stroke and a higher risk for cardiovascular death.[6-9] The rate of hospitalization due to cardiovascular disease and mortality among patients with impaired lung function was found to be twice those with normal lung function[7] A review described that for every 10% decrease in FEV1, all-cause mortality increases by 14%.[10] In individuals aged 40-59 years and > 60 years, there was respectively a 2 and 3mmHg increment in pulse pressure for every one standard deviation decrement in FEV1 which further increased the risk for cardiovascular events.[11] These complications can disrupt the physical capabilities, social identities and life trajectory of sufferers leading to depression even within the context of strong family support.[12] Attempts at reducing the incidence and prevalence of cardiovascular complications associated with hypertension have made studying and modifying associated risk factors mandatory. Though the evaluation of lung function is an office procedure which can be done with the use of simple equipment such as the peak flow meter or spirometer, it is not routinely evaluated among patients with hypertension when assessing their cardiovascular risk. For the formulation of management protocols with regards to lung function evaluation among hypertensive patients, there must be enough evidence based on available data, thus the need for assessing the lung function of patients with hypertension. This study compared the lung function of hypertensive with normotensive patients.

Methods

Study area:

The study was carried out at the General outpatient clinic of the Department of Family Medicine, University College Hospital (UCH), Ibadan. UCH is the first tertiary hospital in the West African sub-region established in 1957. The general outpatient clinic is an urban-based family practice which serves as the gateway for most patients presenting to the hospital.

Study design:

A comparative cross-sectional hospital-based study was conducted between the 1st of May and the 21st of July 2017.

Study population

Adult patients aged 40-60 years with and without hypertension who

presented at the general outpatient clinic, UCH.

Inclusion criteria-

Consented hypertensive adults between the ages of 40 to 60 years who had been diagnosed with hypertension (BP ≥140/90mmHg) for at least one year and normotensive adults between the same ages who had never had their blood pressure ≥140/90mmHg.

Exclusion criteria-

Individuals with exposure to dusty occupation, previous diagnosis of asthma, chronic obstructive pulmonary disease, emphysema or current symptoms suggestive of obstructive lung disease, smokers, chest deformity and contraindication to spirometry procedure, acutely ill patients, hypertensive patients on beta-blocker medication and non-consenting patients.

Sampling method

The respondents were selected using a systematic random sampling technique.

Sample size estimation:

It was calculated using the formula proposed for the calculation of the number of participants per study group for unmatched comparative studies[13]. Where P1 (96.0%) was the proportion of hypertensive patients with poor lung function[14], and assuming a 15% statistical difference, P2 was 81.0%. Thus, the minimum sample size was 95 patients each. Adding a 10% allowance for missing or incompletely filled data, 105 hypertensive and 105 normotensive respondents were recruited.

Data collection:

An interviewer-administered questionnaire was used. The questionnaire had sections on socio-demographic data, duration of hypertension; anthropometric measurements (weight and height) with a calculated BMI, two blood pressure readings and a calculated average for each respondent. A pulmonary function test was carried out using spirometry (SPIROBANK II®) at a side lab in the general outpatient clinic to determine the respondent's FEV1, FVC, FEVI/FVC ratio and PEF. In performing the test, standard operating procedures were observed and the results were verified by a consultant pulmonologist. The best test result of three readings was compared with the spirometer-predicted value for the patient's age, sex, height and race. If the value of FEV1% was less than 80% of the predicted value an obstructive lung pattern was said to occur. If the FVC was low but FEV1% normal or increased, it was interpreted as a restrictive lung pattern.[15] Both restrictive and obstructive lung function patterns were categorized as poor lung function while values of FVC, FEV1 and FEV1/FVC (FEV1%) > 80% were classified as normal.

Data analysis

The data collected was analyzed using the Statistical Package for Social Sciences (SPSS) version 20. Socio-demographic characteristics, anthropometric measurement and clinical characteristics of the two study groups were summarized using percentages, mean values and standard deviation. The results were presented using a graph and tables. Based on lung function, each study group was divided into two groups: those with poor lung function and those with normal lung function measures. The proportion of hypertensive and normotensive patients with poor lung function was computed and expressed in percentage. Comparison of categorical variables (BMI, waist circumference, blood pressure, duration of hypertension and lung function) was done using chi-square tests.

Logistic regression analysis of the presence or absence of poor lung function on blood pressure was done by adjusting for socio-demographic and clinical variables.

The level of significance was set at $p < 0.05$.

Ethical considerations.

Ethical clearance was obtained from the Ethical Review Committee of the University of Ibadan/University College Hospital Ibadan Institutional Review Board (UI/EC/16/0245). Informed consent was obtained from each study participant and the confidentiality of the respondents was guaranteed by anonymity of respondents.

RESULTS

All the 210 respondents (105 hypertensives and 105 normotensives) who were recruited completed all aspects of the study.

Socio-demographic characteristics of the study respondents

Table I shows the socio-demographic characteristics of the respondents. The proportion of female respondents was higher in the two groups (hypertensive 56.2%, normotensive 51.4%) compared with the male respondents. The mean age of the hypertensive group was higher (51.89± 6.04years) than those of the normotensive group (48.5± 5.89 years). The majority in both groups were married, had formal education and earned more than the minimum wage.

Table I: Socio-demographic characteristics of respondents

Variables	Hypertensive 105 (%)	Normotensive 105 (%)	Total 210 (%)
Age (in years)			
40 - 44 years	15 (14.3)	34 (32.4)	49 (23.3)
45 – 49 years	23 (21.9)	29 (27.6)	52 (24.8)
50 – 54 years	22 (21.0)	20 (19.0)	42 (20.0)
> 55 years	45 (42.8)	22 (21.0)	67 (31.9)
Gender			
Male	46 (43.8)	51 (48.6)	97 (46.2)
Female	59 (56.2)	54 (51.4)	113 (53.8)
Educational level			
Nil	4 (3.8)	2 (1.9)	6 (2.8)
Primary	17 (16.2)	10 (9.5)	27 (12.9)
Secondary	28 (26.7)	24 (22.9)	52 (24.8)
Tertiary	56 (53.3)	69 (65.7)	125 (59.5)
Average monthly income			
≤ 18,000	22 (21.0)	13 (12.4)	35 (16.7)
> 18,000	83 (79.0)	92 (87.6)	175 (83.3)
Ethnicity			
Yoruba	94 (89.5)	91 (86.7)	185 (88.1)
Others (Igbo & Hausa)	11 (10.5)	14 (13.3)	25 (11.9)

Clinical characteristics of respondents

Table II shows that the mean blood pressure (p=<0.001), weight (p=0.031), body mass index (p=0.003) and waist circumference

(p=0.004) were significantly higher among the hypertensive group compared with the normotensive group.

Table II. Clinical characteristics of respondents.

Variables	Hypertensive Mean (SD)	Normotensive Mean (SD)	t-test	p Value
Current Systolic Blood Pressure (mmHg)	132.70 (17.52)	119.48 (12.67)	-6.264	**<0.001**
Current Diastolic Blood pressure (mmHg)	81.39 (8.97)	75.08 (8.68)	-5.182	**<0.001**
Weight (kg)	75.71 (15.64)	71.10 (15.00)	-2.175	**0.031**
Height (m)	1.64 (0.08)	1.66 (0.08)	1.809	0.072
BMI (kg/m^2)	28.11 (6.00)	25.72 (5.47)	-3.007	**0.003**
Waist circumference (cm)	96.59 (12.92)	91.54 (11.87)	-2.953	**0.004**

Significantly, a higher proportion of the hypertensive 35(33.3%) had poor lung function compared with the normotensive 22(21%), p= 0.044 as shown in Figure 1. Among the respondents with hypertension, 22.9% had restrictive lung function patterns and 10.4% had obstructive patterns while among the normotensive respondents, 17.1% had restrictive patterns and 3.8% had obstructive lung function patterns.

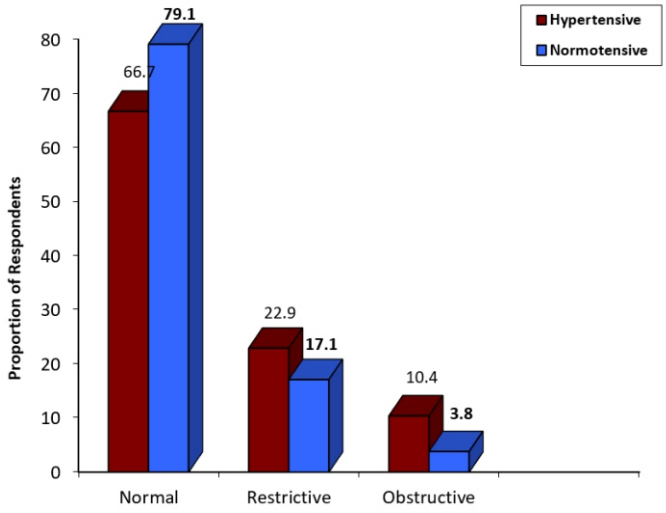

Figure 1: Pattern of lung function among respondents

Risk factors for poor lung function in the study respondents

Table III shows that uncontrolled blood pressure was significantly associated with poor lung function (p=0.024) while in the normotensive group, abnormal waist circumference was significantly associated with lung function (p=0.048).

Table III: Bivariate analysis showing the association between clinical characteristics and lung function.

Variables	Hypertension 105(%) Normal	Poor	χ^2	p-value	Normotensive 105(%) Normal	Poor	χ^2	p-value
BMI								
Normal	25 (71.4)	10 (28.6)	0.760	0.684	40 (80.0)	10 (20.0)	0.115	0.944
Overweight	26 (66.7)	13 (33.3)			27 (77.1)	8 (22.9)		
Obese	19 (61.3)	12 (38.7)			16 (80.0)	4 (20.0)		
Waist circumference								
Normal	20 (71.4)	8 (28.6)	0.390	0.533	34 (89.5)	4 (10.5)	3.909	**0.048**
Abnormal	50 (64.9)	27 (35.1)			49 (73.1)	18 (26.9)		
Current BP								
Normal	48(75.0)	16(25.0)	5.122	**0.024**	-	-	-	-
Uncontrolled	22(53.7)	19 (46.3)			-	-		
Duration of Hypertesion								
≤ 5 years	33 (47.1)	18 (51.4)	0.172	0.679	-	-		
> 5 years	37 (52.9)	17 (48.6)			-	-		

Significance P<0.05

Logistic regression showing the factors associated with lung function among the hypertensive and normotensive group as shown in Table IV after adjusting for age, waist circumference and BMI, shows that among the hypertensive group, respondents with current blood pressure greater than 140/90mmHg are about three times more likely to have poor lung function (OR: 2.995, 95% C.I. 1.243-7.171) while in the normotensive group with every unit increase in waist circumference above normal, respondents are five times more likely to develop poor lung function(OR: 4.579, 95% C.I. 1.136-18.465).

Table IV: Logistic regression showing the factors associated with lung function among the hypertensive and normotensive groups.

Variables	Odds ratio(OR)	95% C.I. for Odds ratio	p-value
Hypertension Group			
Current BP			
Abnormal	2.995	1.243-7.171	**0.014**
Normal	-	Ref	-
Waist circumference			
Abnormal	1.165	0.347-3.919	0.805
Normal	-	Ref	-
BMI			
Obese	0.783	0.31-19.967	0.882
Overweight	0.506	0.21-12.051	0.674
Normal	-	Ref	-
Age	1.397	0.559-3.490	0.474
Normotensive Group			
Waist circumference			
Abnormal	4.579	1.136-18.465	**0.032**
Normal	-	Ref	-
BMI			
Obese	90131460.00	0.000	0.999
Overweight	112496485.3	0.000	0.999
Normal	-	Ref	-
Age	1.215	0.456-3.234	0.679

DISCUSSION

This study described the comparison of lung function among hypertensive and normotensive attendees of the General outpatient in a tertiary health facility in southwest Nigeria. More of the hypertensive respondents had poor spirometry value, abnormal waist circumference and uncontrolled blood pressures were significantly associated with poor lung function.

The mean age of the hypertensive group (51.89± 6.04) was significantly higher than that of the normotensive group which is in line with the prevalence of hypertension which rises with age.[12-14] The mean weight and BMI of the hypertensive respondents were significantly higher than that of the normotensives. Similar to this, is the finding of Schnabel et al in Germany where the respondents with hypertension had higher BMI (28.3±3.9) compared to the normotensive (24.0±3.5).[12] Several other researchers have found similar results.[12-16,] This finding can be said to be a result of the association between obesity and hypertension, as it has been established that obesity is a risk factor for developing hypertension.[13]

With regards to waist circumference, in this current study, hypertensive respondents had higher values compared with the normotensive and this also is similar to the findings of Bello-Ovosi in an urban community in North-Western Nigeria.[15] This finding is in line with the association between waist circumference as one of the indicators of central obesity and hypertension by Shah et al.[17]

This current study showed that the hypertensive group had a significantly higher proportion of respondents with poor spirometry values than the normotensive group. This is shown by the reduced

values of all the pulmonary parameters in the hypertensive group compared with the normotensives. Population-based studies carried out in Germany and Iceland showed a similar significant decrease in FVC, FEV1, PEF and FEV1/FVC in hypertensive subjects compared with persons without hypertension.[14, 18, 19] Though the reasons for the association between reduced lung function and hypertension are yet to be fully understood, one possible hypothesis is that chronic hypertension causes left ventricular dysfunction resulting in increased left atrial pressure. This might lead to an increase in pulmonary artery pressure resulting in an increase in interstitial oedema in the lung causing a decrease in FEV1 and FVC values.[19] Furthermore, it was observed that a higher percentage of respondents in the hypertension group had restrictive lung function patterns compared to the normotensive group, which is similar to the findings of a restrictive pattern of lung function in hypertensive persons reported by other researchers.[10, 12, 14, 18] Shah et al and Qurershi et al, however, found a higher proportion of obstructive pattern of lung function amongst the respondents probably due to the bronchoconstriction effect of the beta blocker class of antihypertensive that the hypertensive patients were on.[20,21]

In this study, uncontrolled blood pressure was found to be a predictor of poor lung function among the hypertensive respondents. A mare diagnosis of hypertension was not associated with poor lung function but hypertension with current blood pressure greater than 140/90mmHg (i.e. uncontrolled hypertension) was found to be inversely associated with poor lung function. Though the pathophysiology of the association between high blood pressure and lung function is not yet fully understood several other studies have found the same association. [10, 14, 18, 19] A parallel physiological pathway for elastic changes is hypothesized for declines in arterial elasticity and lung function.[8] Endothelial dysfunction and inflammation which occurs in hypertension could potentially decrease the elasticity of both arterial vasculature and lung tissue.[8]The decreased elasticity in the arterial vasculature leads to arterial stiffness within the lungs and may lead to decreased lung function.[21] As documented by Schnabel et al, the Framingham study carried out in the 1980s found an inverse relationship between forced vital capacity (FVC) and cardiovascular diseases.[12] This and other studies found that a decline in forced vital capacity and forced expiratory volume in one second were strong inverse predictors of the future development of hypertension and cardiovascular diseases.[12,22] Furthermore, among hypertensive patients there is a persistent low-grade systemic inflammation indicated by elevated C-reactive protein levels which has been associated with poor lung function.[5,14]

The effects of obesity on pulmonary function parameters are influenced by the amount and distribution of body fats. Both BMI and Waist circumference are usual measures of overweight and obesity but abdominal fat measured by waist circumference correlates to intra-abdominal fat which can influence respiratory mechanics irrespective of BMI by limiting diaphragmatic expansion.[23] In this study, waist circumference was noted to be inversely associated with lung function but not with BMI. This finding is in agreement with a population based study on anthropometric measurements and lung function carried out by Rowe et al and that of a cross-sectional study by Svartengren et al in which central obesity and not just high BMI was related to poor lung function.[24,25]

CONCLUSION

In this study, poor lung function was observed more among hypertensive respondents and restrictive pattern was the predominant lung function abnormality. Uncontrolled blood pressure was a predictor of poor lung function among the hypertensive respondents while waist circumference above normal was a predictor of poor lung function among the normotensive respondents.

IMPLICATION FOR PRACTICE

This study recommends intensified weight reduction counselling to improve the lung function of all patients either hypertensive or normotensive, continuous counselling on medication adherence for hypertensive patients, particularly those with uncontrolled blood pressure as they may develop poor lung function which becomes an added risk for both cardiovascular and cerebrovascular events and lastly, this study advocates for lung function evaluation with the use of spirometry, a simple office procedure which can be done by primary care physician, as part of the cardiovascular risk assessment for hypertensive patients.

LIMITATIONS

Being a hospital-based study; the findings may not be generalized to the general population. Non-matching of the study respondents due to the short duration of data collection. Lack of measurement of lung volumes to ascertain true restrictive and obstructive lung function patterns due to lack of needed equipment.

REFERENCES

1 Fisher NDL, Curfman G. Hypertension—A Public Health Challenge of Global Proportions. JAMA. 2018;320(17):1757-9. DOI: 10.1001/jama.2018.16760

2 Oguoma VM, Nwose EU, Skinner TC, Digban KA, Onyia IC, Richards RS. Prevalence of cardiovascular disease risk factors among a Nigerian adult population: relationship with income level and accessibility to CVD risks screening. BMC Public Health. 2015;15:397.

3 Garcia-Larsen V, Bustos P, Amigo H, Potts J, Rona RJ. Ventilatory function and cardiovascular disease risk factors: a cross-sectional study in young adults. BMC Pulmonary Medicine. 2014;14(1):1-8.

4 Magnussen C, Ojeda FM, Rzayeva N, Zeller T, Sinning CR, Pfeiffer N, et al. FEV1 and FVC predict all-cause mortality independent of cardiac function - Results from the population-based Gutenberg Health Study. International journal of cardiology. 2017;234:64-8.

5 Silvestre OM, Nadruz W, Roca GQ, Claggett B, Solomon SD, Mirabelli MC, et al. Declining Lung Function and Cardiovascular Risk. Journal of the American College of Cardiology. 2018;72(10):1109-22. DOI: doi:10.1016/j.jacc.2018.06.049

6 Ramalho SHR, Shah AM. Lung function and cardiovascular disease: A link. Trends in Cardiovascular Medicine. 2021;31(2):93-8. DOI: https://doi.org/10.1016/j.tcm.2019.12.009

7 Wang B, Zhou Y, Xiao L, Guo Y, Ma J, Zhou M, et al. Association of lung function with cardiovascular risk: a cohort study. Respiratory Research. 2018;19(1):214. DOI: 10.1186/s12931-018-0920-y

8 Jankowich MD, Taveira T, Wu; W-C. Decreased Lung Function Is Associated With Increased Arterial Stiffness as Measured by Peripheral Pulse Pressure: Data From NHANES III. American journal of hypertension. 2010;23(6):614-9.

9 Charan J, Biswas T. How to Calculate Sample Size for Different Study Designs in Medical Research? Indian Journal of Psychological Medicine. 2013;35(2):121-6.

10 Yadav A, Sankhla M, Yadav K, Rahul. Association of Hypertension and Pulmonary Functions. International Multispecialty Journal of Health (IMJH) 2015;1(3):15-9.

11 Johnson JD, Theurer WM. A Stepwise Approach to the Interpretation of Pulmonary Function Tests. American family physician. 2014;89(5):359-66.

12 Schnabel E, Nowak D, Brasche S, Wichmann HE, Heinrich J. Association between lung function, hypertension and blood pressure medication. Respiratory Medicine. 2011;105(5):727-33.

13 Ajayi IO, Sowemimo IO, M. AO, Ossai NE. Prevalence of hypertension and associated factors among residents of Ibadan-North Local Government Area of Nigeria Nigerian Journal of Cardiology. 2016;13(1):67-75.

14 Margretardottir OB, Thorleifsson SJ, Gudmundsson G, Olafsson I, Benediktsdottir B, Janson C, et al. Hypertension, systemic inflammation and body weight in relation to lung function impairment-an epidemiological study. Copd. 2009;6(4):250-5.

15 Bello-Ovosi BO, Asuke S, Abdulrahman SO, Ibrahim MS, Ovosi JO, Ogunsina MA, et al. Prevalence and correlates of hypertension and diabetes mellitus in an urban community in North-Western Nigeria. Pan African Medical Journal 2018;29(97).

16 Osalusi BS, Uantioje EI, Ogun SA, Afe TO, Adeeko OO. The prevalence of hypertension among the adults in a semi-urban community in southwest Nigeria. International Journal of Medical and Health Research. 2017;3(8):93-9.

17 Shah SM, Loney T, Sheek-Hussein M, El Sadig M, Al Dhaheri S, El Barazi I, et al. Hypertension prevalence, awareness, treatment, and control, in male South Asian immigrants in the United Arab Emirates: a cross-sectional study. BMC Cardiovascular Disorders 2015;15(30):1-11.

18 Schnabel E, Karrasch S, Schulz H, Glaser S, Meisinger C, Heier M, et al. High blood pressure, antihypertensive medication and lung function in a general adult population. Respiratory Research. 2011;12(50):1-8.

19 Pramodh V, Bhanu R. Pulmonary function tests in hypertensive patients. Journal of Dental and Medical Sciences. 2015;14(10):6-9.

20 Shah S, Shaikh M, Gupta Y, Nahar P, Zingade U, Kowale A. Pulmonary Function Tests in Hypertension. International Journal of Pharma Sciences and Research 2014; Vol 5 (7):338

21 Qureshi R, Prajapati P, Sanghavi S, Saiyad S, Mehta J, Mehta A. Evaluation of pulmonary function in hypertensive patients taking antihypertensive drugs. International Journal of Basic & Applied Sciences IJBAS-IJENS. 2014;3(1):265-8.

22 Jacobs DR, Yatsuya H, Hearst MO, Thyagarajan B, Kalhan R, Rosenberg S, et al. Rate of decline of forced vital capacity predicts future arterial hypertension: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. Hypertension. 2012;59(2):219-25.

23 Chowdhury SG, Mandal O, Datta A, Chakraboti D. Effect of Central adiposity on lung function tests in young adults. Journal of Dental and Medical Sciences. 2015;14(8):24-8.

24 Rowe A, Hernandez P, Kuhle S, Kirkland S. The association between anthropometric measures and lung function in a population-based study of Canadian adults. Respiratory Medicine. 2017;131:199-204. DOI: https://doi.org/10.1016/j.rmed.2017.08.030

25 Svartengren M, Cai G-H, Malinovschi A, Theorell-Haglöw J, Janson C, Elmståhl S, et al. The impact of body mass index, central obesity and physical activity on lung function: results of the Epi Health study. ERJ Open Research.2020;6(4):00214-2020. DOI: 10.1183/23120541.00214-2020